

Hardware Findings & Recommendations

(H-1)

- **Description**
 - OMI's require the Sound Suppression 48" valves to open within two seconds, however the requirement is not specified in a higher level document
 - This is an important test on a critical component
 - Two of the three pre-launch Sound Suppression valves must open to satisfy launch commit criteria
 - Opening times are recorded but not trended
- **Recommendations**
 - Suggest trending 48" valve opening times using existing Maximo capabilities as a way of determining degradation
 - Add a review of the trends generated to the pre-S0007 review
 - Build routine Maximo work orders to collect and trend both the pre-launch static test and LCC data recorded during launch countdowns



- Evaluate alternatives for documenting design requirement for valve timing

Hardware Findings & Recommendations

(H-2)

- **Description**
 - The hydraulic side of the actuators for the Sound Suppression 48" valves are overly complicated.
- **Recommendations**
 - Consider the cost / benefits of a re-designed actuator



Hardware Findings & Recommendations

(H-3)

- Description

- At both Pads tubing in user panels and tubing in systems downstream of these panels will not be replaced by the GSS GN2 tubing replacement project
- GN2 tubing experiences known pitting problems.

- Recommendations

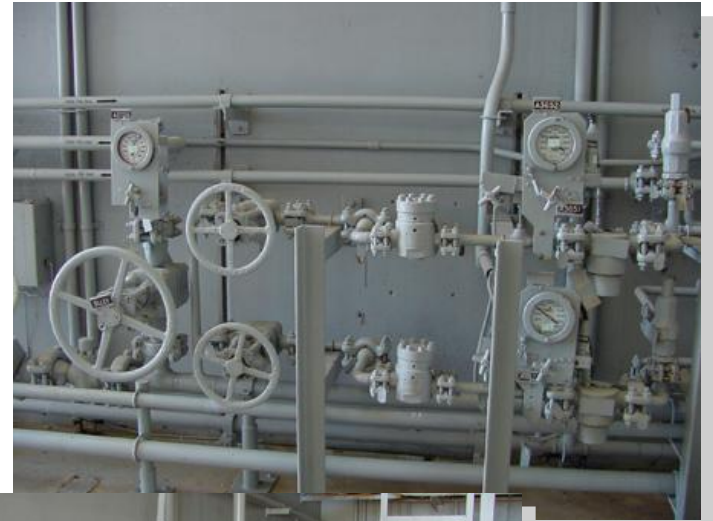
- Need to address
- Selection of replacement tubing with a higher corrosion resistance is under development as part of the Pad tubing replacement project
 - Systems should use this new tubing



Hardware Findings & Recommendations

(H-4)

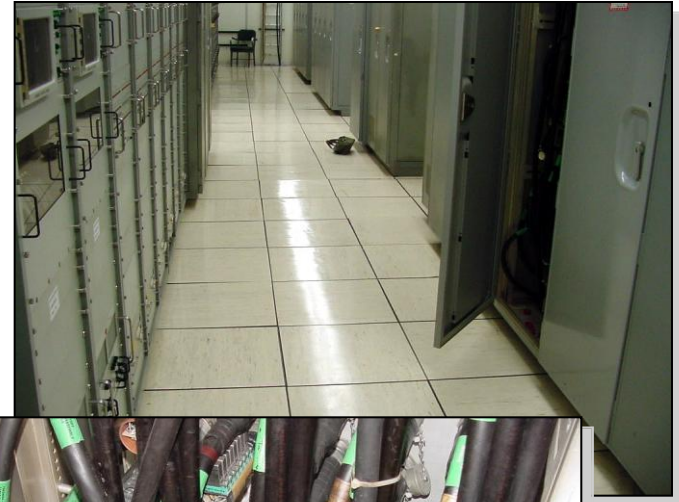
- **Description**
 - The only documented maintenance on the GN2 6K to 3K regulator panels are:
 - Performance of PVS (Pressure Vessel Certification) at 5 years
 - An annual filter change
 - The calibration of gauges and relief valves
- **Recommendations**
 - Develop preventive maintenance tasks to inspect for corrosion and other types of degradation



Hardware Findings & Recommendations

(H-5)

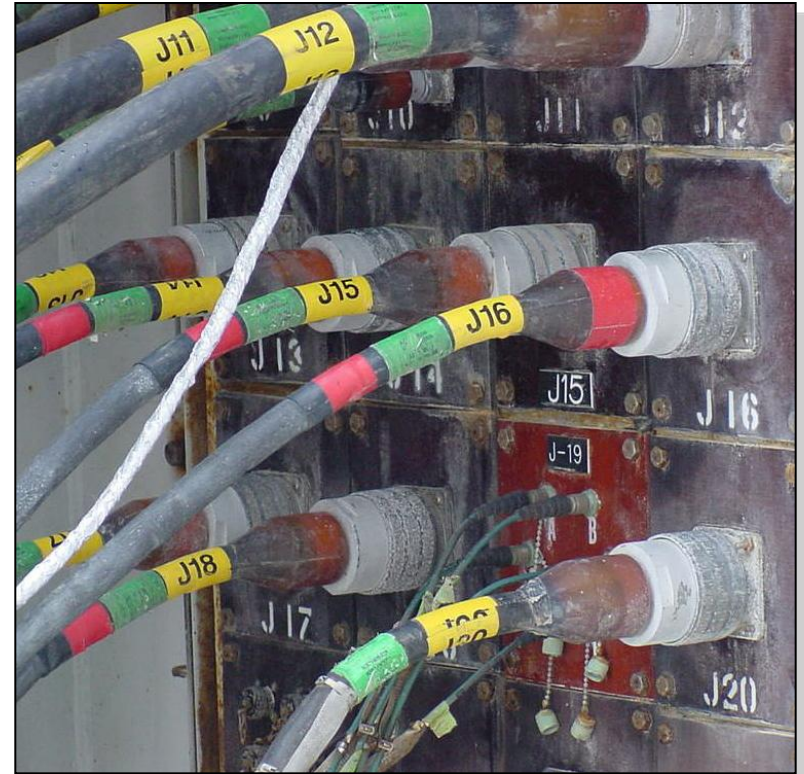
- Description
 - Not all Engineering departments may be aware of their hardware and component responsibilities
 - Responsibility for maintenance on the Receptacle Distribution rack in Pad room 210. Maintenance of cables that connect 28v DC power supplies to patch racks, and of the 28v DC power supplies themselves
- Recommendations
 - Clarify specific responsibility



Hardware Findings & Recommendations

(H-6)

- **Description**
 - Sound Suppression cable connections on the MLP 9099 interface are interchangeable and can be mistakenly cross-connected
 - An instance of cross-connection was found on a recent flow
 - A large number of the protective caps for these connections are also untethered
- **Recommendations**
 - The 9099 Interface ERB Action Team is addressing this issue



Hardware Findings & Recommendations

(H-7)

- **Description**
 - There is a concern as to whether welded caps over the nuts holding down flame trench mushroom water nozzles may be hiding extensive corrosion
- **Recommendations**
 - Perform a random sampling inspection of the nuts holding down flame trench mushroom nozzles
 - Would require temporary removal of some welded caps



Hardware Findings & Recommendations

New (H-8)

- **Loss of Check Valves 54/55 would cause pre-fill leakage. Procedure to compensate for this and system leaks could require personnel to enter the MLP during final phases of Launch countdown to manually re-adjust pre-fill valves.**
- **Improper sealing of these check valves could cause pre-fill leakage and a possible launch delay.**

A study should be conducted to determine the consequences of a loss of pre-fill due to CK-54/55 leakage. Consider running an actual sound suppression water test to understand additional flow time and other effects of having no pre-fill in place. Test would address three separate possibilities; 1) Loss of pre-fill on pre-launch leg. 2) Loss of pre-fill on post-liftoff leg

Hardware Findings & Recommendations

New (H-9)

- There is no way to remotely monitor (or accurately observe, after red team departs the pad) Sound Suppression pre-launch and post-liftoff water line fill levels.
- Based on water flow test results or a study conducted to determine the consequences of a loss of pre-fill; if the water level is crucial, consider a re-design to provide a remote monitoring capability.

Hardware Findings & Recommendations

New (H-10)

- Check Valves CK-54 and CK-55 leakage is not recorded or trended. (It can be measured at CS115.12) If leakage exceeded trickle fill rates it could cause a launch delay.
- Trend the leakage rate of the CK-54/55 check valves. Set up alert limits based on those trends within Maximo to initiate corrective action.

Hardware Findings & Recommendations

New (H-11)

- There are two ways of draining residual water from the MLP pipes after launch. The leakage of either of which could cause the potential loss of launch pre-fill.
- Study redesign or maintenance options for valves V114.1 and V-120 in order to detect and/or prevent unacceptable leakage of pre-fill.

Hardware Findings & Recommendations

New (H-12)

- The V-24 valve is needed to fill, then top off the Sound Suppression tank in the final phases of Launch preparation. There are several failures that could cause loss of functionality.
- Additional engineering studies should be conducted to determine if there should be additional redundancy designed into V-24. (I.e. Add accumulator and pressure switch indications)

Hardware Findings & Recommendations

New (H-13)

- Different drawings show Sound Suppression GN2 supplied from regulator panels at both the FSS 175" level and from the ground level storage battery. GN2 Engineering says a mod was made to tie in at the ground level supply.
- Update the Pad Water System drawing to reflect the latest GN2 configuration

Hardware Findings & Recommendations

New (H-14)

- Although the Pad Water System is fed redundant power from separate sources via two parallel breakers. Redundant busses and commands within the Water System controls are tied together in such a way that a short circuit can (in many cases) affect both the primary and redundant buss.

John Lorch will provide update to Text

An Engrg study should be done:

- Near-term: Put in fuses
- Long-term: A project to accomplish this should be submitted and coordinated with the implementation of INCS, which will replace the Pad Water system patchracks & patchboards.

Water systems should trend the amperage readings for the system using Maximo trend capabilities.

Process Findings & Recommendations

(P-1)

- Description

- Pad utilization does not allow adequate time to perform needed corrosion control with existing personnel
 - Sound Suppression valve V24 accumulator at Pad A is heavily corroded
 - General evidence of painting being performed over the top of corrosion

- Recommendations

- Initiate evaluation / decision mechanism to address Pad corrosion coverage issues
- Possibly charter a special PIT Team to document pros and cons of the following three recommendations:
 1. Assign a painter to work with every shop;
 2. Assign a dedicated paint crew to each Launch Pad;
 3. Train techs to properly use Corrosion Control materials (locally stocked) and procedures within specified limits



Process Findings & Recommendations

(P-2)

- **Description**
 - Proper corrosion treatment of launch pad components is much more difficult once they are installed
 - This is especially true if vendors were not held to following KSC corrosion coating specifications - (The Pad A V24 accumulator is a good case in point.)
- **Recommendations**
 - Ensure design coating specifications work in concert with the Corrosion SMRP (K-L70A-SMRP-002) to identify appropriate corrosion coatings for launch pad modifications and replacement parts
 - Coordinate with Reliability Engineering to possibly add these areas of interest to their Design Review Checklist
 - Route components, expected to be used in the Launch Pad environment, for corrosion treatment of their exterior prior to being stored for spares
 - Treatment to include:
 1. Complete removal of any Enamel paint used by OEM not compatible with KSC corrosion coatings
 2. Replacement of Carbon Steel Bolts with Galvanized Bolts. [Caution: Corrosion processing needs to ensure adequate protection of easily damaged valve seats and seals]



Process Findings & Recommendations

(P-3)

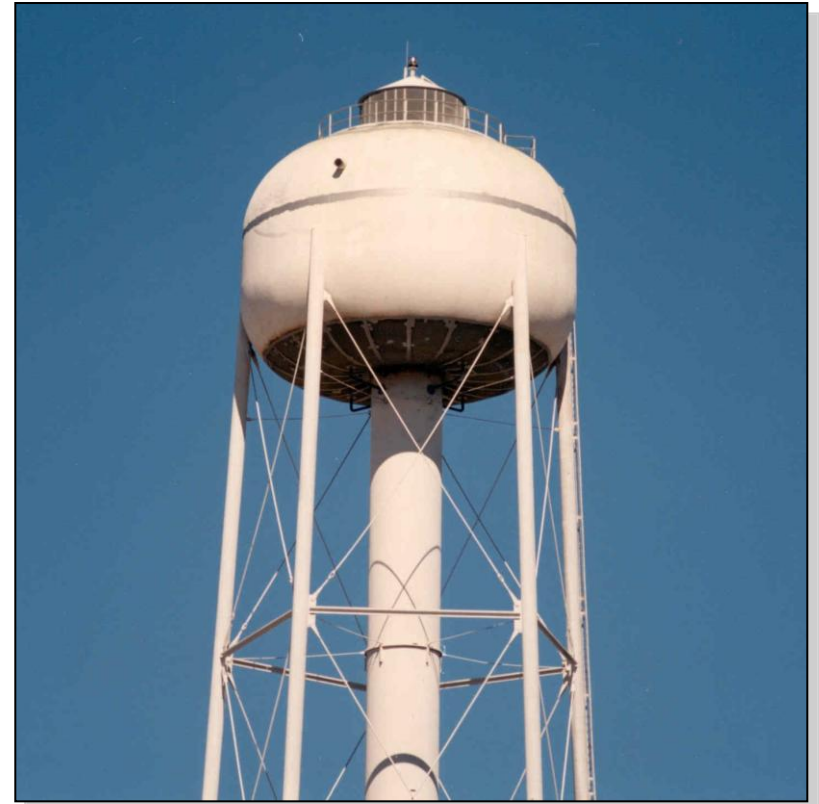
- **Description**
 - Interviews with Corrosion Control personnel suggested that some areas of the Sound Suppression valve complex require a more thorough washdown
- **Recommendations**
 - Review the post-launch procedure (S2005) to ensure an adequate wash-down rinses SRB residue and local salt sprays from Sound Suppression lines and associated component valves, etc.



Process Findings & Recommendations

(P-4)

- **Description**
 - The current corrosion control effort does not adequately address concerns about the internal surfaces of the Sound Suppression System for smaller diameter piping
- **Recommendations**
 - The corrosion control process needs to be expanded to address issues pertaining to the interior of the smaller Sound Suppression piping
 - Options might include:
 1. Taking water samples to determine if the Sound Suppression water pipes become contaminated between flows
 2. Evaluating random sample pieces of the smaller pipes to see if any internal corrosion treatment would be necessary in those areas
 3. Use borescope inspection techniques



Process Findings & Recommendations

(P-5)

- **Description**

- Walk-down inspections are currently conducted on Sound Suppression systems on board the MLP post-launch
- These inspections have not been effective in finding the following problems:
 1. Water pipes inside the MLP had several clamps that appeared to be chaffing and at least one retaining nut that could be turned by hand.
 2. Piping / tubing appeared to be inadequately supported (e.g. lower rainbird drain valve)

- **Recommendations**

- Consider initiating a detailed calendar-based MLP Sound Suppression pipe inspection to generate quantitative data on system integrity
- Make J-pipe, J-pipe support, and Side Flame Deflector weld integrity inspections part of the scheduled maintenance program



Note: Once developed a similar inspection approach needs to be taken on launch pad Sound Suppression ground based elements as well

Process Findings & Recommendations

(P-6)

- **Description**
 - The 48” sound suppression valve bleed-down procedure to remove air from hydraulic system could be performed more effectively
- **Recommendations**
 - Change the existing 48” valve bleed-down procedure to improve maintenance practice



Process Findings & Recommendations

(P-7)

- **Description**
 - No complete inspection of Sound Suppression cable runs performed at any interval
- **Recommendations**
 - Suggest end-to-end (HIMS to end device) Sound Suppression cable inspections be performed, where accessible, at an interval to be determined



Process Findings & Recommendations

(P-8)

- **Description**
 - No explicit maintenance documented to establish that a positive purge exists on each Sound Suppression 48" valve control panel
 - Current process used by Technicians to inform Engineering of purge issues is not effective
- **Recommendations**
 - Consider entering condition assessment ratings on purged control cabinets into Maximo
 - This data could then be used to generate Engineering notices based on an established condition monitoring threshold



Process Findings & Recommendations

(P-9)

- **Description**
 - The Critical spares list for the Sound Suppression system needs to be updated
- **Recommendations**
 - Update the Sound Suppression Critical Spares List

Process Findings & Recommendations

(P-10)

- **Description**
 - TR 1287 does not accurately reflect the correct O&M department code
 - According to TR1287, O&M of water and pneumatic PMN's are the responsibility of the Structures Department
- **Recommendations**
 - TR1287 is currently being updated as part of an GSWT action item.
 - These discrepancies will be corrected as part of this action

Process Findings & Recommendations

(P-11)

- Description
 - According to the current test procedures the Sound Suppression polling rate is not increased to high data rate during pre-launch tests
- Recommendations
 - Revise the documentation so when verifying limit switch position on the console, the polling rates are changed to match that experienced during an actual launch



Process Findings & Recommendations

New (P-12)

- In the launch commit criteria document, the water system engineers are not identified as points of contact for sound suppression issues. [Currently only lists Launch Accessories Engineers]
- Modify the field on the appropriate Launch Commit Criteria pages to designate responsible Water System Engineers

Process Findings & Recommendations

New (P-13)

- The two Pads have inconsistencies in their listing of BOI (Break of Integrity) procedures for accessing or closing out racks related to the Sound Suppression System.
- Need to investigate BOI procedures for the racks in room 210 at both pads

Process Findings & Recommendations

New (P-14)

- Drawing E.O.s are not being updated in a timely manner.
- Incorporate Drawing E.O.s on a more regular basis.

Process Findings & Recommendations

New (P-15)

- No steps to ensure trickle fill on post-liftoff lines, valves and nozzles.
- Add procedural steps to ensure trickle fill on post-liftoff lines, valves and nozzles. Check for leakage after Rainbird nozzles filled.

Process Findings & Recommendations

New (P-16)

- No documented procedures to monitor pre-launch or post-liftoff fill levels.
- Based on proposed Water flow test establish procedures needed to ensure monitoring.

Process Findings & Recommendations

New (P-17)

- No current maintenance task specifies inspecting V-24 Compressed Air actuator nor associated lines.
- Add steps to Sound Suppression and Pneumatic documentation to inspect V-24 valve, associated compressed air actuator and lines for condition and integrity.

Process Findings & Recommendations

New (P-18)

- No weld inspections required by the maintenance documentation on the side flame deflector or J-pipe access platform.
- Add side flame deflector, J-pipe access platform and associated equipment to the Team's weld inspection recommendation.

Process Findings & Recommendations

New (P-19)

- Post launch MLP piping inspection done by Corrosion Control not adequately documented. An initiation or work kickoff mechanism also needs to be developed.
- Document inspection with a Job Plan referenced in an integrated OMI.

Process Findings & Recommendations

New (P-20)

- No flow test performed on the Pad A & B P-1 pumps as required by NFPA.
- Set up procedure to perform annually required test.

Process Findings & Recommendations

New (P-21)

- The MLP interface seal inspection/maintenance documentation is inadequate.
- Add details to interface inspection procedure to specifically look for any indentation remaining from previous MLP mate. This could be a sign of reduced resiliency.

**RCM Maintenance Analysis database
comments often inadequate for
follow-up investigations**

- 1. Accomplish a second pass RCM analysis of the Sound Suppression System**
- 2. Emphasize importance of elaborating on logic in RCM logic database note fields**

RCM Findings & Recommendations

New (R-2)

- The L&L Re-usable Hdwe Assessment pathfinder Team found that the L&L treatment of targeted systems and interfaces was complimentary to the more detailed RCM coverage of system components and their failure modes.
 - There were two reservations expressed:
 - 1) That Streamlined RCM didn't sufficiently capture new failure modes not connected to an existing OMI or Job plan maintenance step.
 - 2) That some RCM analysis was not done in a full Team environment.
1. Continue to improve and apply the Streamlined RCM approach. This process analyses failure modes derived from current maintenance document (Bottom-up). Take maximum advantage of Maximo capabilities to reduce clerical aspects of the RCM process.
 2. Support the addition of a Classic RCM capability in the USA Shared Resource including identification and purchase of specialized software to facilitate it's accomplishment and documentation. [The Maintenance Assessment Team Agenda recommended for future Teams follows a typical Classical RCM approach. (A review of maintenance requirements from the top-down.)]
 3. Facilitate full support of a first or second RCM analysis pass with representation from all the affected organizations.

RCM Findings & Recommendations

New (R-3)

- Streamlined RCM was applied to the Pad Water Systems, including Sound Suppression more than a year ago. A print out of that analysis was reviewed with the L&L Re-usable Hdwe Assessment Team. [At least three members of the current L&L Team were part of that analysis effort.]
 - No recommendation to change the maintenance program on the Sound Suppression aspects of the Pad Water Systems was indicated in a published summary of that effort.
 - Some new hardware has been installed within the Pad Water and Sound Suppression systems. Creation/revisions to the O&M procedures for this equipment have not been completed.
1. Perform a second pass RCM analysis on the Pad Water & Sound Suppression Systems after the current OMIs are updated and released.
 2. For Pad Water Systems consider directing the Streamlined RCM analysis more toward the dynamic components such as pumps, motors etc., rather than the static pipes and structure.
 3. Consider the application of a Classic RCM approach on newly procured or highly modified hardware or at the discretion of future L&L Re-usable Hdwe Assessment Teams.

RCM Findings & Recommendations

New (R-4)

- **Changes generated by RCM analysis**
Teams are not getting incorporated in documents released to the floor.
Engineers in some departments were never specifically directed to implement any changes generated from the RCM analysis effort.
 - **The results of individual RCM studies**
were also not distributed effectively to associated Engineers unable to participate directly on the Analysis Team.
1. **Strengthen Engineering and Shop Managements' support of the RCM process and it's performance and follow-up.** [Especially at the mid and lower levels.]
 2. **Support Shared Resource enhancement of the RCM Logic Database Program through the addition of additional report capabilities and general 'User Friendliness'.**

RCM Findings & Recommendations

New (R-5)

- The current RCM Shared Resource is not staffed to support Re-usable Hdwe Assessment Teams on top of it's current scope.
- Support the expansion of the USA RCM Shared Resource to enable support of Re-usable Hdwe Assessment Teams.

RCM Findings & Recommendations

New (R-6)

- A long-range, consistent plan needs to be developed on how RCM relates to or can tie in with the L&L Re-usable Hdwe Assessment process.
- Consider simultaneous accomplishment of a first or second pass RCM analysis by the Re-usable Hdwe Assessment Team itself. (Enlist an RCM mentor to coordinate a timely and thorough analysis)
- Or, if the Re-usable Hdwe Assessment Teams are retained as on-going efforts. Include the performance of, and change implementation related to RCM analysis as one of it's purposes.
- Monitor implementation of maint. changes identified.

Misc. Findings & Recommendations

New (M-1 – M-5)

M-1 Inefficient access to Sound Suppression MLP valve V-31.

- Include MLP V-31 valve access in NASA CoF Fall Protection funding package

M-2 There are no O&M procedures to operate the new Firex diesel pumps.

- Install valves per standard

M-3 Discovered that the orbiter Firex does not have series / parallel valves. [Does not comply with KSC-STD-F-0004 that requires this arrangement on systems which interface with (or spray on) Flight Hardware.]

- Expedite the approval and release of Firex diesel pump procedures. Consider using Classic RCM analysis methodology.

M-4 MLP internal electrical substation co-located with large Firex water lines.

- Investigate protection / shielding for mechanical components to alleviate potential leakage risk caused by with large Firex water lines and valves being co-located in MLP electrical substation.

M-5 Discrepancies exist between 79K40021 and 79K03469 drawings on correct Patch rack to Sound Suppression HIM connections.

- Update drawings as required.

Misc. Findings & Recommendations

New (M-6 – M-9)

M-6 Preventative maintenance is not being performed on the following equipment in Pad Rm 210: 1) the 28VDC distribution bus; 2) Circuit Breaker panels feeding the 28VDC power supplies.

➤ **Establish needed maintenance.**

M-7 Both paths of MLP Firex signals are sent thru one connector at the 9099 interface.

➤ **Conduct study to assess feasibility of redesigning the Firex 9099 connectors.**

M-8 Cable trays internal to the MLP are overloaded with cables (including Sound Suppression) and badly in need of maintenance.

➤ **No Recommendation**

M-9 The structural supports for some of the electrical conduits and smaller water pipes on the east side of J7-1388 (Firex Pump house) have collapsed. Wires are exposed thru broken portions of the conduit.

➤ **Work order needs to be written to correct these problems.**

Misc. Findings & Recommendations New (M-10 – M-12)

M-10 Pad water pipe Insulation and freeze protection tape is not being maintained well. (e.g. Pad Firex electric pump area)

- Re-evaluate freeze protection methods and policy for equipment residing in launch pad environment. Consider removing and replacing tape at specified intervals to inspect for underlying corrosion.

M-11 MLP pipe labeling is not consistent. KSC specifications on labeling / color coding requirements have changed over the years.

- Label MLP piping as needed to comply with current KSC standards.

M-12 Need to replace a lot of aging, obsolete hardware related to the Sound Suppression System.

- No Recommendation